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METRIC SYSTEM

BEAVER & WALTON

THE

METRIC SYSTEM

OF

WEIGHTS AND MEASURES

BY

E. P. SEAVER AND G. A. WALTON

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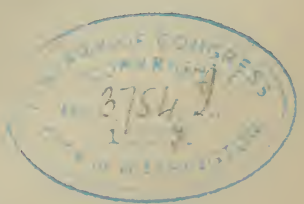

BOSTON
WILLIAM WARE AND COMPANY
[SUCCESSORS TO BREWER AND TILESTON]
1878

PREFACE.

THE following pages, taken mainly from the Franklin Written Arithmetic, are intended to present the Metric System of Weights and Measures in a simple and practical way, for the purposes of school instruction.

This system has been presented by itself, unencumbered by comparisons between its units and the units now in common use. Such comparisons are given at the end. This course is believed to be the best; for pupils will form clear and lasting impressions of the meter, the liter, the gram, their multiples and subdivisions, not by being told how many inches, quarts, or grains they are equivalent to, but *by seeing and using the actual measures and weights* until he becomes perfectly familiar with them. When a pupil knows the new measures well, he may then begin to make comparisons between the new measures and the old.

A table of specific gravities has been added, with a few examples to illustrate its usefulness, especially when employed in connection with metric weights and measures.

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THE

METRIC SYSTEM

OF

WEIGHTS AND MEASURES.

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§ 1. The metric system of weights and measures, now used in the greater part of Europe and coming into use in the United States, is derived from the standard METER.

NOTE. The word METER means a *measure*. The standard meter is a certain bar of platinum carefully preserved at Paris. Copies of this bar, made with the utmost precision, have been procured and are carefully preserved by the nations that have adopted the Metric System. The standard meter of the United States is such a copy, and it is kept at Washington. The meter-sticks made for ordinary use are copies of the standard meter.

MEASURES OF LENGTH.

§ 2. The standard unit of length in the metric system is the ***meter.***

NOTE. The teacher should show the pupil a meter and its subdivisions. If none can readily be obtained, a meter can easily be made from the decimeter represented on the next page. This meter may be divided into decimeters and centimeters. From this measure the pupils can easily make their own of paper or wood.

§ 3. One tenth of a meter is a ***dĕc'i-meter.***

NOTE. The prefix **deci-** means *one tenth of.*

§ 4. One hundredth of a meter is a ***cĕn'ti-meter.***

NOTE. The prefix **centi-** means *one hundredth of.*

§ 5. One thousandth of a meter is a ***mĭl'li-meter.***

NOTE. The prefix **milli-** means *one thousandth of.*

§ 6. Exercises on the Meter and its subdivisions.

a. How many meters long is the room? How many meters wide?

b. How many decimeters long is the table?

c. How many decimeters wide is the door?

d. How many centimeters long and wide is your slate? the window-pane? etc.

e. How many millimeters apart are two lines on a sheet of writing-paper?

f. How many millimeters thick is your slate-frame? your ruler? etc.

g. How many millimeters are there in one centimeter?

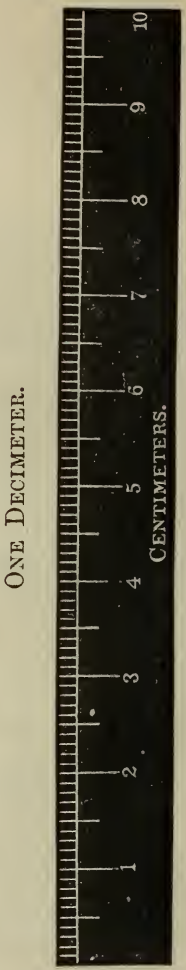
h. How many centimeters are there in one decimeter?

i. How many decimeters are there in one meter?

j. How many millimeters are there in one decimeter? in one meter?

k. How many centimeters are there in 37 millimeters, and how many millimeters remain?

l. How many decimeters are there in 84 centimeters, and how many centimeters remain?



m. How many meters are there in 347 centimeters, and how many centimeters remain?

n. In measuring the length of the room, did you find it to be an exact number of meters long?

o. If not, how many decimeters do you find in the remainder? Do you find an exact number of decimeters?

p. If there is still a remainder, how many centimeters do you find in it?

To write Numbers in the Metric System.

§ 7. To express a length in meters and parts of a meter, we write whole meters in the units' place, decimeters in the tenths' place, centimeters in the hundredths' place, and millimeters in the thousandths' place.

Thus, if a room is found to be 8 meters 6 decimeters 9 centimeters long, we write:

Length of the room = 8.69 meters.

2 decimeters 3 centimeters 5 millimeters is written:

0.235 meters.

§ 8. The abbreviations used in writing expressions of length are: For meters, *m*; for decimeters, *dm*; for centimeters, *cm*; and for millimeters, *mm*.

§ 9. Lengths may be expressed in other denominations as well as in meters, *by putting the decimal point at the right of the place of the required denomination, and writing the proper name or abbreviation after the figures.*

Thus, 0.235^{m} may be written 2.35^{dm}, 23.5^{cm}, or 235^{mm}. So also 728^{mm} may be written 72.8^{cm}, 7.28^{dm}, or 0.728^{m}.

§ 10. **Exercises in reading Numbers.**

Read the following:

a. 5^{m}	*e.* 5.926^{m}	*i.* 6.58^{dm}
b. 47^{m}	*f.* 36^{dm}	*j.* 3.4^{cm}
c. 3.9^{m}	*g.* 428^{cm}	*k.* 43.7^{cm}
d. 4.21^{m}	*h.* 23^{mm}	*l.* 2.5^{mm}

§ 11. **Examples for the Slate.**

Change the following to meters:

(1.) 1^{dm}	(4.) 1^{cm}	(7.) 1^{mm}
(2.) 13^{dm}	(5.) 38^{cm}	(8.) 48^{mm}
(3.) 214^{dm}	(6.) 529^{cm}	(9.) 3675^{mm}

Multiples of the Meter.

§ 12. Besides the meter and its subdivisions, there are longer measures, which are multiples of the meter.

§ 13. The *děk'a-meter* is ten times as long as the meter.

NOTE. The prefix **deka-** means *tenfold.*

§ 14. The *hěk'to-meter* is a hundred times as long as the meter.

NOTE. The prefix **hekto-** means *a hundredfold.*

§ 15. The *kĭl'o-meter* is a thousand times as long as the meter.

NOTE. The prefix **kilo-** means *a thousandfold.*

§ 16. The *mў'rĭa-meter* is ten thousand times as long as the meter.

NOTE. The prefix **myria-** means *ten thousandfold.*

NOTE. Of these longer measures, the kilometer is used in measuring distances on roads, canals, rivers, etc. The other measures are much less frequently used; the myriameter hardly ever.

§ 17. Exercises on the Multiples of the Meter.

a. Measure off a string ten meters long. What name is given to the length of this string?

NOTE. The string may be used in measuring distances. For this purpose it will be well to make knots at the end of each meter.

b. Measure in dekameters and meters the length and breadth of the school-yard; of a garden; of a field, etc.

c. Measure off in the street, or other convenient place, a distance of 10 dekameters. What name is given to this distance?

d. Walk from the beginning to the end of the distance thus measured off, and count your paces. How many of your paces make a hektometer?

e. How many of your paces would make a kilometer?

f. How many kilometers from your home to the school-house?

g. How long does it take you to walk a kilometer?

h. How many kilometers can you walk in an hour?

i. If 1500 of your paces make a kilometer, how many make a dekameter?

§ 18. To express distances in meters and multiples of a meter, we write meters in the units' place, dekameters in the tens' place, hektometers in the hundreds' place, and so on.

§ 19. To express a distance in kilometers, we write kilometers in the units' place, and then hektometers, dekameters, and meters will be written in the tenths', hundredths', and thousandths' places respectively.

Thus, if the distance from one town to another is found to be 9780 meters, the usual form of writing would be 9.78 kilometers.

NOTE. The greatest distances are usually expressed in kilometers. Thus, the distance of the earth from the sun is about 149000000 kilometers.

§ 20. The abbreviations used in writing are: For the dekameter, *Dm*; for the hektometer, *Hm*; and for the kilometer *Km*.

§ 21. Table of Long Measure.

10 millimeters (mm)	=	1 centimeter (cm).
10 centimeters	=	1 decimeter (dm).
10 decimeters	=	1 meter (m).
10 meters	=	1 dekameter (Dm).
10 dekameters	=	1 hektometer (Hm).
10 hektometers	=	1 kilometer (Km).
10 kilometers	=	1 myriameter (Mm).

§ 22. Oral Exercises.

Read the following:

a. 123^{m}	*d.* 42^{Dm}	*g.* 49^{Km}
b. 497.6^{m}	*e.* 36.7^{Dm}	*h.* 593.7^{Km}
c. 346^{Hm}	*f.* 57.5^{Hm}	*i.* 6000^{Km}

§ 23. Examples for the Slate.

Change the following to meters:

(10.) 425^{Dm}	(13.) 94.6^{Hm}	(16.) 0.72^{Km}
(11.) 35^{Hm}	(14.) 9.24^{Km}	(17.) 0.073^{Hm}
(12.) 23.5^{Km}	(15.) 39.7^{Dm}	(18.) 0.05^{Km}

Addition, Subtraction, Multiplication, and Division of Metric Numbers.

§ 24. ILLUSTRATIVE EXAMPLE. Change to meters and add 14.83^{Dm}, 75.6^{Hm}, and 948^{cm}.

WRITTEN WORK.

$14.83^{Dm} = 148.3^{m}$
$75.6^{Hm} = 7560.$
$948^{cm} = 9.48$
7717.78^{m}

Explanation. — When these expressions have been changed to meters, they are all of the same denomination, and the sum is found in the same way as in the addition of simple numbers.

§ 25. *Numbers expressing metric measures and weights are added, subtracted, multiplied, and divided by the same rules as apply to simple numbers.*

§ 26. Examples for the Slate.

19. Add 5.6^{m}, 24.07^{m}, 30.5^{m}, and 7.508^{m}.

20. Express as meters and add 582^{cm}, 6428^{dm}, and 495^{mm}.

21. Express as meters and add 369^{Dm}, 4073^{Hm}, and 5^{Km}.

22. Add 48.06^{m}, 709.63^{m}, 3708.9^{m}, 800.9^{m}, and express the answer in kilometers.

23. If 7^{Km} be taken from 42^{Km}, how many meters remain?

24. From 87.04^{m} take 42^{cm}.

25. The distance round a certain park is 2.58 kilometers. How many meters will a man go who rides around it six times?

26. A school-boy walked one third around the above park in 12 minutes. How many meters did he walk in 1 minute?

27. How many kilometers in $36.68^{m} \times 2004$?

28. Divide 38.07^{m} by 4 and by 3, and add the answers.

29. Ellen's hoop is 3.6^{m} around. How many times will it turn in rolling a distance of 1.08^{Km}?

MEASURES OF SURFACE.

§ 27. The units used in measuring surfaces are squares, each having sides equal to a unit of long measure.

Thus, a ***square meter*** is a square having sides one meter long; a ***square decimeter*** is a square having sides one decimeter long; etc.

§ 28. Exercises.

a. How many square decimeters in a square meter? Illustrate by drawing a square meter on the blackboard or on the floor and dividing it into square decimeters.

b. How many square centimeters in a square decimeter? Illustrate by drawing a square decimeter on your slate and dividing it into square centimeters.

c. How many square meters in a square dekameter?

§ 29. The square dekameter, when used as a unit of land measure, takes a special name, and is called an ***ar***. One hundredth of an *ar*, which is one square meter, is called a ***centar***. A hundred *ars*, equal to one square hektometer, is called a ***hektar***.

§ 30. Square Measure.

100 square millimeters (sq mm) = 1 square centimeter (sq cm).
100 square centimeters = 1 square decimeter (sq dm).
100 square decimeters = 1 square meter (sq m) = 1 centar (ca).
100 square meters = 1 square dekameter = 1 ar (a).
100 square dekameters = 1 square hektometer = 1 hektar (Ha).
100 square hektometers = 1 square kilometer (sq Km).

§ 31. As the units of square measure form a scale of hundreds, in writing numbers expressing surface two decimal places must be allowed for each denomination.

Thus, $45^{\text{sq m}}\ 4^{\text{sq dm}}\ 86^{\text{sq cm}}$ are written $45.0486^{\text{sq m}}$; and $7^{\text{Ha}}\ 6^{\text{a}}\ 5^{\text{ca}}$ are written 706.05^{a}.

§ 32. Examples for the Slate.

30. How many square meters of carpeting will be required to carpet a room 5.3 m long and 4.5 m wide ?

31. How many meters of carpeting 0.7 m wide will be required to carpet a room 4 m long and 3.5 m wide ?

32. What is the cost of polishing the surface of a rectangular piece of marble 2.8 meters long and 1.2 meters wide, at $2.50 per sq. meter ?

33. In a piece of land 15 m long and 14.5 m wide are how many square meters or centars ? how many ars ?

34. Express the following in ars and add them : 1.3 hektars, 155.5 ars, 43 hektars, 26 centars.

35. A had 6 hektars, 7 ars, 9 centars of land, and sold 0.2 of it at $54 an ar. How much did he receive for what he sold ?

MEASURES OF VOLUME.

§ 33. The units used in measuring cubic contents, or volume, are cubes, each having its edges equal to a unit of long measure.

Thus, the *cubic meter* is a cube having edges one meter long; a *cubic decimeter* is a cube having its edges one decimeter long; etc.

§ 34. Exercises.

a. How many cubic decimeters in a cubic meter ?

b. How many cubic centimeters in a cubic decimeter ? Illustrate by means of a cubical block having edges one decimeter long, marked off into centimeters.

§ 35. The cubic meter, when used as a unit of measure for wood and stone, takes a special name, and is called a *ster.*

§ 36. The cubic decimeter, when used as a unit of liquid or dry measure, is called a *liter.*

§ 37. Cubic Measure.

1000 cubic millimeters (cu mm) = 1 cubic centimeter (cu cm).
1000 cubic centimeters = 1 cubic decimeter (cu dm) = 1 liter.
1000 cubic decimeters = 1 cubic meter (cu m) = 1 ster.

§ 38. Wood Measure.

10 decisters (ds) = 1 ster (s).
10 sters = 1 dekaster (Ds).

§ 39. As the units of cubic measure form a scale of thousands, in writing numbers expressing volume three decimal places must be allowed for each denomination.

Thus, 427 $^{cu\ m}$ 29 $^{cu\ dm}$ 3 $^{cu\ cm}$ are written 427.029003 $^{cu\ m}$.

§ 40. As the units of wood measure form a scale of tens, only one decimal place is needed for each denomination.

Thus, 7 dekasters 5 sters 6 decisters are written 75.6 sters.

§ 41. Examples for the Slate.

36. Express the following in cubic meters and add them: 7 cu. meters 40 cu. decimeters; 5 cu. meters 3 cu. decimeters 19 cu. centimeters; 25 cu. centimeters 49 cu. millimeters.

37. How many cubic meters of earth must be removed to dig a cellar 14.5 ^{m} long, 4.6 ^{m} wide, and 2.3 ^{m} deep?

38. At $1.25 a cubic meter, what will it cost to dig a trench 75.5 ^{m} long, 2.2 ^{m} wide, and 1.8 ^{m} deep?

39. How many loads of earth, each filling 2.25 $^{cu\ m}$, will fill a space 15.4 ^{m} long, 12 ^{m} wide, and 4.5 ^{m} deep?

40. If a cubic centimeter of gold is worth $12.50, what is the value of a brick of gold 2.4 ^{cm} long, 1.3 ^{cm} wide, and 0.75 ^{cm} thick?

41. If I burn 27 sters of wood in the three winter months, what must be the length of a pile 1 meter wide and $\frac{3}{4}$ meter high to last a month, and what will it cost at $2.25 a ster?

MEASURES OF CAPACITY.

§ 42. The primary unit of measure for all substances that can be poured into a dish or box is the *liter.*

§ 43. A liter is equal in volume to one cubic decimeter.

§ 44. Larger and smaller measures are derived from the liter in the same way that longer and shorter measures are derived from the meter, that is, by taking decimal multiples and subdivisions.

§ 45. Liquid and Dry Measures.

	1 milliliter (ml)	= 1 cu cm.
10 milliliters	= 1 centiliter (cl).	
10 centiliters	= 1 deciliter (dl).	
10 deciliters	= 1 liter (l)	= 1 cu dm.
10 liters	= 1 dekaliter (Dl).	
10 dekaliters	= 1 hektoliter (Hl).	
10 hektoliters	= 1 kiloliter (Kl).	= 1 cu m.

NOTE. The milliliter is employed in computations, but rarely, if ever, in actual measurements. Chemists and druggists use cubic centimeters instead of milliliters.

§ 46. Examples for the Slate.

42. If one hektoliter of kerosene costs $20, what is the price of a liter?

43. What must be paid for 2.5 liters of milk each day for a week, at 7 cents a liter?

44. From a vessel containing 1 hektoliter of syrup, 25 liters were drawn out. How many liters remained?

45. How many hektoliters of oats can be put into a bin that is 2^m long, 1.3^m wide, and 1.5^m deep?

46. What must be the length of a bin 1 meter wide and 1 meter deep, to contain 4500 liters of grain?

WEIGHTS.

§ 47. The primary unit of weight is the ***gram.***

§ 48. A gram is the weight of one cubic centimeter of pure water at the temperature of 4 degrees centigrade (= 39.2 degrees Fahrenheit), at which temperature water has its greatest density.

§ 49. Larger and smaller weights are derived from the gram by taking decimal multiples and subdivisions.

§ 50. Weights.

10 milligrams (mg)	= 1 centigram (cg).	
10 centigrams	= 1 decigram (dg).	
10 decigrams	= 1 gram (g)	= wt. of 1 cu cm of water.
10 grams	= 1 dekagram (Dg).	
10 dekagrams	= 1 hektogram (Hg).	
10 hektograms	= 1 kilogram (K)	= wt. of 1 cu dm of water.
10 kilograms	= 1 myriagram (Mg).	
10 myriagrams	= 1 quintal (Q).	
10 quintals	= 1 metric ton (T.)	= wt. of 1 cu m of water.

NOTE I. The gram, kilogram, and metric ton are the only units used in actual weighing, except by jewellers, druggists, and those who weigh very small or very expensive articles, like gold or powerful medicines.

NOTE II. The kilogram is generally called the kilo. The kilo is the unit of weight for weighing common articles, such as sugar, tea, etc.

NOTE III. The metric ton is used to weigh very heavy articles, like hay, coal, etc.

§ 51. Examples for the Slate.

47. At $0.60 a kilo for honey, what is the cost of 5.15 kilos?

48. At $11 per T. for coal, what will the coal cost to keep a fire one week if 30 kilos are burnt each day?

49. What weight of mercury will a vessel contain whose capacity is 10 $^{\text{cu cm}}$, mercury being 13.5 times as heavy as water?

50. If marble is 2.7 times as heavy as water, what is the weight of a pedestal 1 meter square at each end and 2 meters high?

§ 52. Table of Equivalents.

The equivalents here given agree with those that have been established by Act of Congress for use in legal proceedings and in the interpretation of contracts.

1 inch = 2.540 centimeters.	1 centimeter = 0.3937 inch.
1 foot = 3.048 decimeters.	1 decimeter = 0.328 foot.
1 yard = 0.9144 meters.	1 meter = 1.0936 yds. = 39.37 in.
1 rod = 0.5029 dekameters.	1 dekameter = 1.9884 rods.
1 mile = 1.6093 kilometers.	1 kilometer = 0.62137 mile.
1 sq. inch = 6.452 sq. centimeters.	1 sq. centimeter = 0.1550 sq. inch.
1 sq. foot = 9.2903 sq. decimeters.	1 sq. decimeter = 0.1076 sq. foot.
1 sq. yard = 0.8361 sq. meter.	1 sq. meter = 1.196 sq. yards.
1 sq. rod = 25.293 sq. meters.	1 ar = 3.954 sq. rods.
1 acre = 0.4047 hektar.	1 hektar = 2.471 acres.
1 sq. mile = 2.590 sq. kilometers.	1 sq. kilometer = 0.3861 sq. mile.
1 cu. inch = 16.387 cu. centimeters.	1 cu. centimeter = 0.0610 cu. inch.
1 cu. foot = 28.317 cu. decimeters.	1 cu. decimeter = 0.0353 cu. foot.
1 cu. yard = 0.7645 cu. meter.	1 cu. meter = 1.308 cu. yards.
1 cord = 3.624 sters.	1 ster = 0.2759 cord.
1 liquid quart = 0.9463 liter.	1 liter = 1.0567 liquid quarts.
1 gallon = 0.3785 dekaliters.	1 dekaliter = 2.6417 gallons.
1 dry quart = 1.101 liters.	1 liter = 0.908 dry quart.
1 peck = 0.881 dekaliter.	1 dekaliter = 1.135 pecks.
1 bushel = 3.524 dekaliters.	1 hektoliter = 2.8375 bushels.
1 ounce av. = 28.35 grams.	1 gram = 0.03527 ounce av.
1 pound av. = 0.4536 kilogram.	1 kilogram = 2.2046 pounds av.
1 ton (2000 lbs.) = 0.9072 met. ton.	1 metric ton = 1.1023 tons.
1 grain Troy = 0.0648 gram.	1 gram = 15.432 grains Troy.
1 ounce Troy = 31.1035 grams.	1 gram = 0.03215 ounce Troy.
1 pound Troy = 0.3732 kilogram.	1 kilogram = 2.679 pounds Troy.

§ 53. To change numbers in the metric system to equivalents of the old system:

Examples.

51. In 48 meters how many feet?

52. If you travel 50 kilometers in a day, how many miles do you travel?

53. Change 18 hektars of land to acres.

54. How many inches long is an insect that is 5.2 centimeters long?

55. How many pounds av. are there in 85.6 kilos of salt?

56. How many gallons are there in 24 kiloliters?

57. In 20 metric tons how many tons?

§ 54. To change numbers in the old system to equivalents of the metric system:

Examples.

58. Change 25 miles to kilometers.

59. In 200 acres are how many hektars?

60. How many liters will a cistern hold that measures on the inside 5 feet in length, 4 feet in width, and 4 feet in height?

61. In 3 rods how many meters?

62. Change 18 qt. 1 pt. to liters.

63. In 1 lb. 7 oz. 18 pwt. of gold, how many grams?

64. What is the weight of a barrel of flour (196 lbs.) in kilograms?

§ 55. Approximate Equivalents.

The equivalents here given are accurate enough for most purposes, and are easy to remember.

A decimeter	= 4 inches.	A ster	= $\frac{1}{4}$ of a cord.
A meter	= 3 ft. $3\frac{3}{8}$ in., or $1\frac{1}{10}$ yards.	A liter	= 1.06 liquid qt., or $\frac{9}{10}$ of a dry qt.
A dekameter	= 2 rods.	A dekaliter	= 1 peck and 1 qt.
A kilometer	= $\frac{5}{8}$ of a mile.	A hektoliter	= $2\frac{5}{6}$ bushels.
An ar	= 4 sq. rods, or $\frac{1}{40}$ of an acre.	A gram	= $15\frac{1}{2}$ grains.
A hektar	= $2\frac{1}{2}$ acres.	A kilogram	= $2\frac{1}{5}$ pounds av.
		A metric ton	= 2200 pounds av.

56. Miscellaneous Examples.

65. A stage-coach is driven a distance of 70 Km in 8 hours. What is the rate per hour?

66. A horse trotted a distance of 9.6 Km in 40 minutes. How far would he trot in an hour and a half at the same rate?

67. The distance from Boston to Albany is 325 Km. What is the rate of a railway-train that runs this distance in 8 hours and 20 minutes?

68. In walking from his home to the school-house a boy finds that he has taken 2468 paces. If four of his paces are equal to three meters, how many kilometers has he walked? What is the length of a pace in centimeters?

69. How many kilometers will a man walk in $9\frac{1}{2}$ hours if he walks at the rate of 5 kilometers an hour?

70. The distance from either pole to the equator is about ten million meters. How many days and hours would it take a railway-train running at the rate of 50 Km an hour to run around the world?

71. In 324560 hektars of land there are how many square kilometers?

72. What is the cost of a rectangular house-lot 58 m long and 48 m wide at $ 90 an ar?

73. A rectangular field 24 Dm long and 18 Dm wide produces hay at the rate of 75 K to the ar. What is the value of the whole crop at $ 23 a metric ton?

74. How many meters of lining that is 65 cm wide are needed to line 13 meters of silk that is 84 cm wide?

75. What is the cost of carpet for a room 10.5 m long and 8.4 m wide, if the carpet is 84 cm wide and costs $ 3.50 a meter?

76. A speculator bought 252 hektars of land at $ 325 a hektar, and sold $\frac{2}{3}$ of it for house-lots at an average price of 13 cents a square meter. Suppose that $\frac{1}{6}$ of the land is taken up by streets and lanes, and that the land still unsold is worth twice its original cost, what is the amount of gain on the investment?

77. Express 63 cubic centimeters in decimals of a liter?

78. What part of a cubic meter is filled by $62\frac{1}{2}$ dekaliters? by 375 liters?

79. How many bricks, each 20 cm long, 10 cm wide, and 6 cm thick are needed to build a wall 30 m long, 1.8 m high, and 40 cm thick?

80. At \$2.75 a ster, what is the value of a load of wood 2 m long, 1.2 m wide, and 1.65 m high?

81. How many sters of wood may be piled in a wood-shed 7.5 m long, 4.8 m wide, and 4.2 m high?

82. How many double dekaliters full of grain will fill a bin 2 m long, 1 m wide, and 80 cm deep?

83. A bin is 2 m long and 1.15 m wide. How deep must it be to contain 20 hektoliters of grain?

84. A grocer bought 5 hogsheads of molasses, which, when gauged, measured in hektoliters as follows: 2.156, 2.271, 2.198, 2.174, and 2.181. The whole cost \$98.82. At what price a liter must the molasses be sold that there may be a gain of $33\frac{1}{3}$ %?

85. I bought four loads of hay, which weighed 1.625, 1.843, 1.970, and 1.758 metric tons respectively? How many days will this hay last 5 horses if each horse is allowed 18 kilograms a day?

86. A dray is loaded with 48 bags of grain, each bag holding 8 dekaliters. What is the weight of the load in metric tons, allowing 75 kilos of grain to the hektoliter?

87. An arc of one degree on the equator measures 111.3066 kilometers. What is the circumference of the earth at the equator in kilometers?

88. How many bottles each holding half a liter can be filled from a cask containing 1 hektoliter of wine?

89. At 8¢ a liter, what is the cost of supplying a family with 1.5 liters of milk daily through the three summer months?

90. A vender bought a hektoliter of peanuts for \$11, and sold them at 20 cents a liter. How much did he gain?

91. At $2.80 a hektoliter, what is the value of the corn raised on 5.76 hektars of land, the yield being at the rate of 8.3 dekaliters an ar?

92. Express the weight of 364 cubic centimeters of pure water in decimals of a kilogram.

93. What part of a kilogram of water will fill a centiliter? How many kilograms of water will fill a cask holding a hektoliter?

94. What is the capacity in liters of a jar that weighs 5.3 K when empty and 37.8 K when full of water?

95. What is the capacity in dekaliters of a cask that weighs 23.7 K when empty and 129.8 K when full of water?

96. The depth of water in a flume is 8 meters. What is the pressure in kilograms on every square decimeter of the bottom?

97. A liter of dry air weighs 1.293 grams when the thermometer indicates a freezing temperature and the mercury in the barometer stands at the ordinary height (76 cm or 30 inches). What is the weight of the air in a room 10 m long, 9.5 m wide, and 4.6 m high, supposing the temperature and pressure to be as above stated?

98. What is the area of Massachusetts in square kilometers, its area in square miles being 7800?

99. What price a liquid quart is equivalent to 15 ¢ a liter?

100. The silver dollar weighs 412½ grains Troy. How many grams does it weigh?

101. What price a peck is equivalent to 80 ¢ a dekaliter?

102. What price a gram is equivalent to 62 ¢ an ounce Troy?

103. A yield of 40 bushels of rye to the acre is equivalent to how many hektoliters to the hektar?

104. If a field produces 60 hektoliters of corn to the hektar, how many bushels is that to the acre?

105. A bushel of wheat weighs 60 pounds. What is the weight of a hektoliter of wheat in kilograms?

106. The pressure of the atmosphere is about 15 pounds to

the square inch. What is that in kilograms to the square decimeter?

107. A "horse-power" is the amount of work that would be required to lift 33000 pounds one foot high in one minute; which is expressed briefly by saying that 1 horse-power equals 33000 foot-pounds per minute. What is the value of 1 horse-power in kilogram-meters per minute?

108. A rectangular lot of land is $\frac{2}{3}$ as wide as it is long, and contains 1944 ars. What is the cost of fencing the land if the fence costs 80¢ a meter?

109. A ladder 15 meters long if placed at a certain point in a street will just reach a window 12 meters above the street on one side, or a window 9 meters above the street on the opposite side. How wide is the street?

110. A barn is 14.4 m wide, and the ridge-pole is 5.4 m higher than the eaves. How long are the rafters? If the barn is 50 m long and 7.5 m high to the eaves, how many square meters of boards will be needed to board up the four sides and the roof?

111. Find the area of a triangle whose base is 1.37 m, and whose height is 1.24 m.

112. The three sides of a triangle measure 50 m, 42 m, and 36 m respectively. What is its area?

113. The four sides of a field measure 421 m, 367 m, 482 m, 402 m respectively, and the diagonal connecting the ends of the two sides first mentioned measures 504 m. What is the area of the field in ars?

114. The two parallel sides of a trapezoid measure 2.53 m and 3.75 m respectively, and the distance between them is 1.54 m. What is the area of the figure?

115. What is the number of square decimeters in a board 4.3 m long, 45 cm wide at one end, and 33 cm at the other?

116. What is the diameter of a tree if the girth is 3.78 m?

NOTE. In examples that require it, the ratio of the circumference to the diameter of a circle is taken to be $3\frac{1}{7}$, unless otherwise stated.

117. What must be the length of a horse's tether that he may be able to graze over just one ar of land?

118. What are the dimensions of the largest square stick of timber that can be sawed out of a log that measures 1.89 ^{m} in girth?

119. A circular park 3.5 dekameters in diameter covers how many ars of land?

120. What is the capacity in cubic meters of a cylindrical tank 2.8 meters deep and 3 meters in diameter?

121. What is the capacity in liters of an ash-can 42 ^{cm} in diameter and 72 ^{cm} deep?

122. A cylindrical vessel is 49 ^{cm} in diameter. How deep must it be to hold 124 ^{K} of water?

123. What is the capacity in liters of a common water-pail which measures 28 ^{cm} in diameter at the top, 22 ^{cm} in diameter at the bottom, and 21 ^{cm} in depth?

Measures for grain are made of wood in cylindrical form, with depth and diameter equal. Taking the ratio of the circumference to the diameter of a circle to be 3.1416, compute in millimeters the dimensions of the following measures, which are the ones commonly used:

(124.) Hektoliter.
(125.) Demi-hektoliter.
(126.) Double dekaliter.
(127.) Dekaliter.
(128.) Demi-dekaliter.
(129.) Double liter.
(130.) Liter.
(131.) Demi-liter.
(132.) Double deciliter.
(133.) Deciliter.
(134.) Demi-deciliter.

Larger measures for liquids are made of copper or tin in the form above described; but the smaller measures are made in cylindrical form, with a depth double the diameter. Compute in millimeters the dimensions of the following measures, made in the form last described:

(135.) Double liter.
(136.) Liter.
(137.) Demi-liter.
(138.) Double deciliter.
(139.) Deciliter.
(140.) Demi-deciliter.
(141.) Double centiliter.
(142.) Centiliter.

SPECIFIC GRAVITY.

57. The specific gravity of a substance is the quotient obtained by dividing the weight of a given volume of the substance by the weight of an equal volume of water.

58. This quotient has been ascertained by experiment for a great variety of substances, and some of the more useful results are given in the following

Table of Specific Gravities.

Alcohol, absolute	0.795	Maple-wood	0.790
Ash-wood	0.845	Marble	2.65 to 2.75
Beech-wood	0.852	Mercury	13.596
Brass, cast	7.820	Milk	1.031
Brass, sheet	8.390	Muriatic acid	1.200
Brick	2.000	Naphtha	0.840
Chestnut-wood	0.565	Nitric acid	1.500
Copper, hammered	8.900	Oak, green	1.113
Cork	0.240	Oak, seasoned	0.743
Diamond	3.530	Olive oil	0.915
Ether, sulphuric	0.715	Pine-wood, hard	0.657
Ebony	1.331	Pine-wood, white	0.551
Glass, flint	3.000	Platinum, hammered	22.060
Glass, crown	2.520	Proof spirit	0.920
Gold, hammered	19.350	Sandstone	2.25 to 2.65
Granite	2.65 to 2.75	Sea-water	1.025
Ice	0.918	Silver, hammered	10.510
Iron, cast	7.250	Steel, soft	7.830
Iron, wrought	7.780	Steel, tempered	7.810
Lead, cast	11.350	Sulphuric acid	1.841
Lignum Vitæ	1.333	Tin, cast	7.290
Limestone	2.60 to 2.70	Wax	0.960
Mahogany-wood	1.063	Zinc	7.190

59. Since a cubic centimeter of pure water weighs 1 gram, a cubic decimeter 1 kilogram, and a cubic meter 1 metric ton, the numbers in a table of specific gravities show

(1) the weight in grams of one cubic centimeter
(2) the weight in kilograms of one cubic decimeter (one liter)
(3) the weight in metric tons of one cubic meter

} of any given substance.

60. From the above statement may be deduced the following

Rules.

1. To find the weight of a substance when its volume is known: *Multiply the volume by the specific gravity.*

2. To find the volume of a given substance when its weight is known: *Divide the weight by the specific gravity.*

61. Examples.

143. What is the weight in kilograms of a cubical piece of cast-iron measuring 12 ^{cm} each way?

144. What is the weight in kilograms of a cannon-ball of cast-iron 17.5 ^{cm} in diameter?

145. What is the diameter of a lead bullet of spherical shape weighing 14 grams?

146. What is the weight of a load of bricks, the number of bricks being 1000, and the dimensions of each 19 ^{cm} long, 8.7 ^{cm} wide, and 6 ^{cm} thick?

147. The front wall of a warehouse extending 15^{m} along the street is of granite, and is supported on iron columns. Find the pressure in metric tons on these columns, supposing the walls to be on the average 50 ^{cm} thick and to rise 12.5 ^{m} above the columns, and making no allowance for windows.

148. A bottle weighing 254 grams when empty holds

1.34 liters. What will it weigh when filled with sulphuric acid?

149. A bottle weighs 803 grams when filled with sulphuric ether and 241 grams when empty. What is the capacity of the bottle in liters?

150. What is the weight in kilograms of a maple plank 4.3 m long, 63 cm wide, and 7.9 cm thick?

151. How many cubic centimeters of water would be displaced by a cubic decimeter of white-pine wood floating in it? What fraction of the block would remain above water?

NOTE. A solid body floating in a liquid sinks far enough to displace its own weight of the liquid.

152. What part of an iceberg floating in the ocean would be under water?

153. A bar of wrought-iron floats in mercury. What part of it is below the surface of the mercury?

154. A solid floating in water is $\frac{5}{6}$ below water. What is the specific gravity of the solid?

155. A bottle holding just 750 cubic centimeters, and weighing when empty 157 grams, is filled with a certain liquid and is then found to weigh 976.5 grams. Find the specific gravity of the liquid.

156. Wishing to ascertain the specific gravity of a piece of metal weighing 1432 grams, I sink it in a vessel that is just full of water and take it out again. Before this was done the vessel full of water weighed 512 grams, but afterwards it weighed only 357 grams. What was the specific gravity of the metal?

157. A piece of wood 1 m long, 30 cm wide, and 10 cm thick, is found to weigh 16.95 K. What is the specific gravity of the wood?

158. A granite obelisk 1 m square at the base, 60 cm square at the top, and 6 m high, terminates in a pyramid 30 cm high, making the total height of the obelisk 6.30 m. What is the weight of this obelisk in kilograms?

ANSWERS.

Ex.	Ans.
1.	0.1 m.
2.	1.3 m.
3.	21.4 m.
4.	0.01 m.
5.	0.38 m.
6.	5.29 m.
7.	0.001 m.
8.	0.048 m.
9.	3.675 m.
10.	4,250 m.
11.	3,500 m.
12.	23,500 m.
13.	9,460 m.
14.	9,240 m.
15.	397 m.
16.	720 m.
17.	7.3 m.
18.	50 m.
19.	67.678 m.
20.	649.115 m.
21.	415,990 m.
22.	5.26749 Km.
23.	35,000 m.
24.	86.62 m.
25.	15,480 m.
26.	$71\frac{2}{3}$ m.
27.	73.50672 Km.
28.	22.2075 m.
29.	300 times.
30.	23.85 sq. m.
31.	20 m.
32.	$8.40.
33.	217.5 ca.; 1.175 a.
34.	4,585.76 a.
35.	$6,556.57.
36.	12.043044049 cu. m.
37.	153.41 cu. m.
38.	$373.72\frac{1}{2}$.
39.	369.6 loads.
40.	$29.25.
41.	12 m.; $20.25.
42.	20¢.
43.	$1.23.
44.	75 l.
45.	39 Hl.
46.	4.5 m.
47.	$3.09.
48.	$2.31.
49.	135 grams.
50.	5.4 T.
51.	15,744 ft.
52.	31.0685 m.
53.	44.478 A.
54.	2.04724 in.
55.	188.71376 lb.
56.	6,340.08 gal.
57.	22.046 T.
58.	40.2325 Km.
59.	80.94 Ha.
60.	2,265.36 l.
61.	15.087 m.
62.	$17.5065\frac{1}{2}$ l.
63.	618.9 g.
64.	88.9056 Kg.
65.	8.75 Km.
66.	21.6 Km.
67.	39 Km. per hour.
68.	1.851 Km.; 75 cm.
69.	47.5 Km.
70.	33 days 8 h.
71.	3,245.6 sq. Km.
72.	$2,505.60.
73.	$745.20.
74.	16.8 m.
75.	$367.50.
76.	$163,800.
77.	0.063.
78.	0.625; 0.375.
79.	18,000.
80.	$10.89.
81.	151.2 s.
82.	80.
83.	0.869 m.
84.	12¢.
85.	$79\frac{43}{45}$ days.
86.	2.88 T.
87.	40,070.376 Km.
88.	200.
89.	$11.04.
90.	$9.
91.	$1,338.62.
92.	0.364 K.
93.	$\frac{1}{100}$; 100.
94.	32.5 l.
95.	10.61 Dl.
96.	80 K.
97.	565 K.
98.	20,202 sq. Km.
99.	14.2¢.
100.	26.73 g.
101.	70.5¢.
102.	1.99¢.
103.	34.83 Hl.
104.	68.9 bu.
105.	77.2 K.
106.	105.4 K.
107.	4,562 kilogram-meters.
108.	$1,440.
109.	21 m.
110.	1,943.76 sq. m.
111.	0.8494 sq. m.
112.	742.9 sq. m.
113.	1,662.3 a.
114.	4.8356 sq. m.
115.	167.7 sq. dm.
116.	1.20 m.
117.	5.64 m.
118.	42.5 cm.
119.	9.625 a.
120.	19.8 cu. m.
121.	99.792 l.
122.	65.7 cm.
123.	10.362 l.
124.	503.1.
125.	399.3.
126.	294.2.
127.	233.5.
128.	185.3.
129.	136.6.
130.	108.4.
131.	86.0. 133. 50.3.
132.	63.4. 134. 39.9.
135.	Dia. 108.4; dep. 216.7.
136.	" 86.0; " 172.0.
137.	" 68.3; " 136.6.
138.	" 50.3; " 100.6.
139.	" 39.9; " 79.9.
140.	" 31.7; " 63.4.
141.	" 23.4; " 46.7.
142.	" 18.5; " 37.1.
143.	12.528 K.
144.	20.345 K.
145.	13.3 mm.
146.	1,983.6 K.
147.	From 248 to 258 T.
148.	2.721 K.
149.	0.786 l.
150.	169.07 K.
151.	551 cu. cm.; $\frac{449}{1000}$.
152.	0.8956, or about $\frac{9}{10}$.
153.	0.572.
154.	$\frac{5}{6}$ or 0.833.
155.	1.093.
156.	9.24.
157.	0.565.
158.	From 10.48 to 10.88 T.

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